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ENGINEERING AND APPLIED SCIENCE

SMALL BUSINESS AWARDS

Completed Projects From Phase I
of the First Small Business Solicitation
(Awarded in October 1977)

September 1979

Directorate for Engineering and Applied Science
National Science Foundation
Washington, DC

(27)

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Introduction

In October 1977, the National Science Foundation (NSF) made 42 awards totaling $1,028,000 to small business firms under the program "Small Business Innovation Applied to National Needs." These awards reflect the interest and support of the National Science Foundation for the Nation's small business community which has strong research capabilities in applied science and engineering. Under the Small Business Innovation Research Program, the Engineering and Applied Science Directorate of the National Science Foundation supports high quality applied research proposals on important scientific or technical problems or opportunities that could have significant public benefit.

Research projects described in this brochure are the result of Phase I awards of the First Small Business Solicitation. Phase I awards were for feasibility research efforts ranging from $17,500 to $25,000.

In this brochure, information is provided about each of the awards and availability of final reports. An abstract summarizing the content of each report is also provided. A sample entry, along with report ordering information, follows this introduction.

How to Order NSF/EAS Small Business Reports

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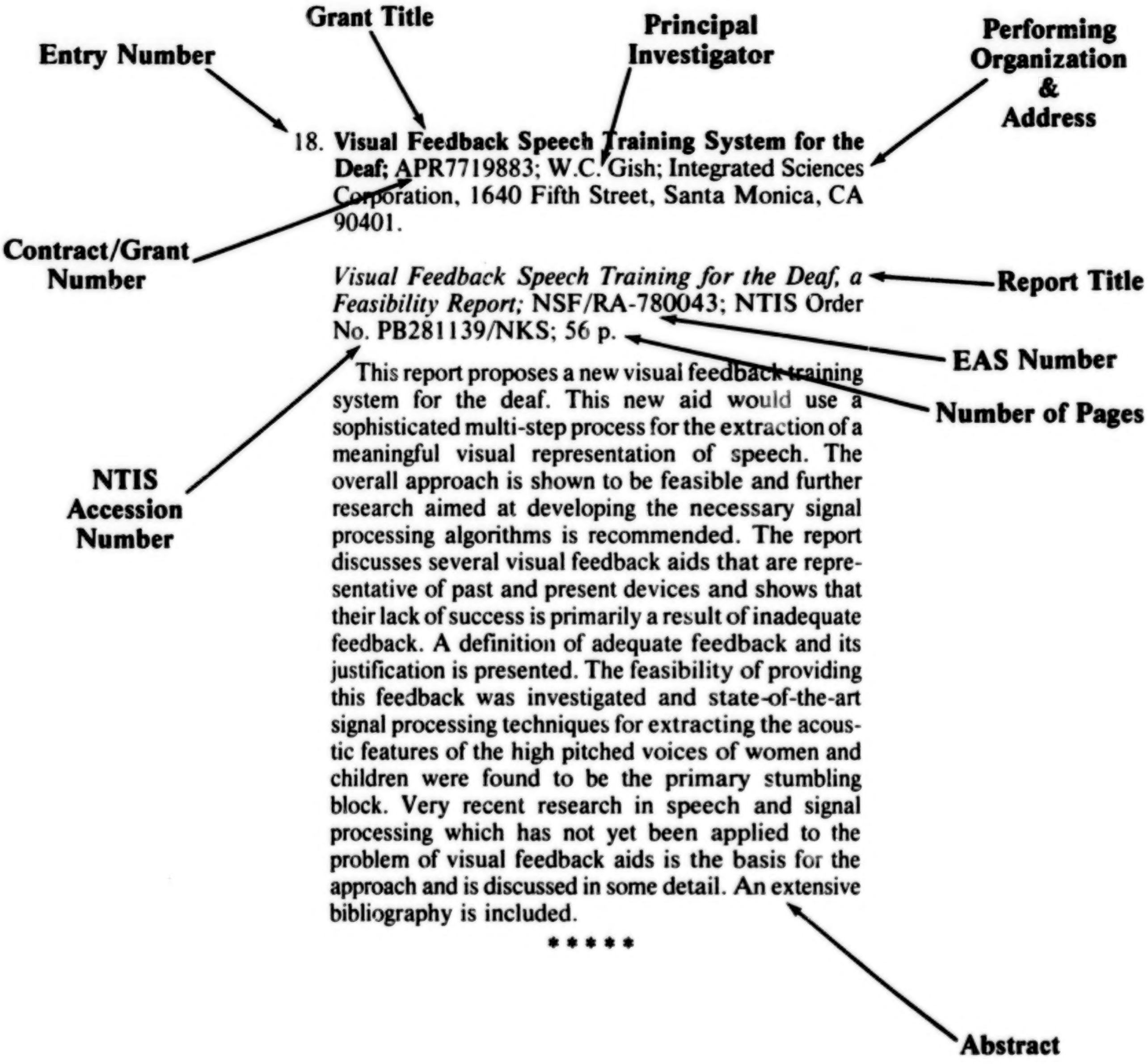

18. **Visual Feedback Speech Training System for the Deaf;** APR7719883; W.C. Gish; Integrated Sciences Corporation, 1640 Fifth Street, Santa Monica, CA 90401.

Visual Feedback Speech Training for the Deaf, a Feasibility Report; NSF/RA-780043; NTIS Order No. PB281139/NKS; 56 p.

This report proposes a new visual feedback training system for the deaf. This new aid would use a sophisticated multi-step process for the extraction of a meaningful visual representation of speech. The overall approach is shown to be feasible and further research aimed at developing the necessary signal processing algorithms is recommended. The report discusses several visual feedback aids that are representative of past and present devices and shows that their lack of success is primarily a result of inadequate feedback. A definition of adequate feedback and its justification is presented. The feasibility of providing this feedback was investigated and state-of-the-art signal processing techniques for extracting the acoustic features of the high pitched voices of women and children were found to be the primary stumbling block. Very recent research in speech and signal processing which has not yet been applied to the problem of visual feedback aids is the basis for the approach and is discussed in some detail. An extensive bibliography is included.

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Citations are arranged in topic categories, alphabetically by grant title within each topic. Entry numbers are assigned consecutively. Indexes following the main body provide access by performing organization, EAS number, contract/grant number, principal investigator and report title and refer to the entry number of the document.

SMALL BUSINESS AWARDS

Abstracts

Hydrometallurgical and Solvent Extraction of Minerals

1. **Bound Liquid Membranes for Hydrometallurgical Processing;** AER7719858; L.D. Nichols; Moleculon Research Corporation, 139 Main Street, Cambridge, MA 02142.

Research on Bound Liquid Membranes for Hydrometallurgical Processing; NSF/RA-780554; NTIS Order No. PB294092; 48 p.

This study was conducted to provide proof of principle for hydrometallurgical membranes based on Poroplastic technology and to assess the practical utility of such membranes for mineral resource recovery. In such membranes a strongly retained ion exchange liquid is used to purify and concentrate aqueous minerals. This represents the next logical step beyond present liquid-liquid extraction technology. Bound liquid membranes force the flow of target ions against a concentration gradient by the charge-coupled transport of some counter-ion down a larger reverse gradient. This phase has demonstrated such transport for nickel and tungstate, two poorly utilized domestic resources, through strong thin Poroplastic membranes impregnated with conventional ion exchange liquids. Transport rates three times those of Celgard are achieved, and liquid retention is far superior to that of Celgard. An engineering study has confirmed that spiral wound Poroplastic membrane modules would be highly effective for extracting dilute tungstate from western lake brines with pay-back periods as short as a few months. These modules reduce mechanical liquid losses, lower ion exchange liquid inventories dramatically, require simpler equipment than liquid-liquid processing, and show numerous advantages over hollow fibers. Charge-specific membranes which distinguish only between anions and cations are also considered, and a new method of hydrometallurgical processing is suggested in which complex brines are made to concentrate their own valuable trace minerals.

* * * * *

2. **Coupled Transport Membranes for Metal Recovery;** AER7719777; W.C. Babcock, R.W. Baker, E.D. LaChappelle, et al.; Bend Research, Inc. Bend, OR 97701.

Coupled Transport Membranes, I. Copper Separations; NSF/RA-780552; Final report not available at this time. For further information please refer to the following journal article: R.W. Baker, M.E. Tuttle, D.J. Kelly, et al. "Coupled Transport Membranes, I. Copper Separations," *Journal of Membrane Science* 2 (1977): 213-33.

A new process for separating and concentrating metals is described, based on the principle of coupled transport. Metal ions such as copper can be "chemically pumped" across a membrane against large concentration gradients by allowing the counterflow of a coupled ion such as hydrogen ion. The process is carried out within a microporous membrane containing within its pores an organic, water-immiscible complexing agent, which acts as a shuttle, picking up metal ions on one side of the membrane, carrying them across the membrane as a complex, and preserving electrical neutrality by carrying hydrogen ions in the opposite direction. Because the flows of metal and hydrogen ions are coupled, the metal ion can be "chemically pumped" from a dilute into a concentrated solution. Energy derives from the flow of hydrogen ions in the opposite direction.

Coupled transport of cupric ion was demonstrated with a Celgard 2400/LIX 64N membrane. Under favorable conditions, copper was concentrated against a 4000-fold concentration difference, and copper was separated from iron with a separation factor greater than 1000. A pH difference of one to two units is sufficient to drive the copper through the membrane at a high rate and separate it from iron. For a given pH gradient across the membrane, the flow of metal ion initially varies linearly with the metal ion concentration gradient, but at high metal ion gradients the flow reaches a limiting value. This appears to be the result of the limited solubility of the metal complex in the organic phase. Typical transport rates are on the order of 3 $\mu g/cm^2$-min or 3 lb./ft^2-year. A short economic assessment based on this flux indicates that processing with coupled transport membranes should be competitive with the best current technology.

* * * * *

3. **The Development of Electrochemical Methods for the Enhancement of Flotation Extraction with Specific Reference to Chromium Ores;** AER7719792; D. Wong, F.H. Cocks, J. Giner; Giner, Inc., 14 Spring Street, Waltham, MA 02154.

Development of Electrochemical Methods For The Enhancement of Flotation Extraction With Specific References to Chromium Ores, Final Report; NSF/RA780556; NTIS Order No. PB297052; 81 p.

A study is presented of the beneficiation of the low-grade domestic chromite ores using both conventional flotation and electro-flotation techniques. The goal is to determine the conditions under which flotation or electro-flotation treatments will effectively result in: (1) a high flotation efficiency (maximum floatability); (2) an increased selectivity to chromite (preferential flotation of chromite rather than gangue); and (3) an improvement in the chromium to iron ratio. It was found that the chromite flotation efficiency depends on the type of surfactant, the ore particle size, the bulk solution pH, and the electrochemical potential control step. Under selected flotation conditions, a simple flotation step was found to increase the chromium oxide content of the ore by a factor of more than 2. The Cr:fe ratio could be improved by 15 percent with the same treatment. This indicates that the ore, while macroscopically homogeneous is microscopically inhomogeneous and contains chromium rich and iron-rich phases. Both flotation and electro-flotation methods appear to be viable ore beneficiation techniques in concentrating and upgrading domestic chromite ores.

*****

4. **Recovery of Chromium from Nickeliferous Laterites;** AER7719538; W.W. Harvey, F.C. Brown, F.T. Rabe, et al.; EIC Corporation, 55 Chapel Street, Newton, MA 02158.

Recovery of Chromium from Nickeliferous Laterites, Phase 1, Final Report; NSF/RA-780555; NTIS Order No. PB296220; 66 p.

There are important economic and strategic incentives for considering co-recovery of chromium. Application of present extractive technologies would leave most of the chromium in process residues, of which the chromium grade would be comparable to that of the original ore. Physical beneficiation of these process residues to yield a very low grade chromite would probably be feasible technically. However, at a value of only several cents per pound of contained chromium, the margin for producing this product form would be very low. Exploratory leach studies defined nitric acid pressure leach conditions under which partial dissolution of chromium could be achieved. More promising results were obtained with hydrochloric acid as leaching agent. Extensive chromium dissolution, together with improved nickel and cobalt extraction, indicate that further work should be done in this system, particularly in the direction of decreasing the conversion of iron and gangue metal oxides to their chlorides.

*****

5. **Solution Mining Process Using Ion Exchange;** AER7719559; D.E. Garrett; Garrett Energy Research and Engineering Co., Inc., 911 Bryant Place, Ojai, CA 93023.

Solution Mining Process Using Ion Exchange, Final Report; NSF/RA-780553; NTIS Order No. PB282897; 114 p.

An exploratory study was performed on solution mining using ion exchangers to solubilize low grade, inaccessible, or otherwise difficult ores. The scope was to briefly examine this concept with many ores and ion exchangers. The research approach was to mix resin, ore, and water, and measure the amount of ore dissolved. Variables of contact time, temperature, additives, countercurrent action, and mechanism were examined, and simulated solution mining tests performed. Many ores rapidly and completely dissolved under mild conditions, and others could be leached at somewhat higher temperatures and residence times. Nickel ores, (lateritic oxides or sulfides; arsenides) were readily leached, and many low grade or refractory ores such as sheelite, rhodonite, fluorite, colemanite, etc. appeared to be particularly easily processed. Some ores, such as most sulfides, required higher temperatures (i.e. 100°C) to be leached. Preliminary economic analyses of representative processes (solution mining of colemanite or laterite; conversion of gypsum to K_2SO_4) showed attractive returns. The feasibility of the new technology looks promising, but the method warrants further investigation to provide more comprehensive screening, additional examination of variables and mechanism, and further basic data development.

*****

Food Crops Better Adapted to Environmental Stress

6. **Feasibility of Introducing Food Crops Better Adapted to Environmental Stress;** AER7719462; A.A. Theisen, E.G. Knox, F.L. Mann; Soil and Land Use Technology, Inc., 11021 Wood Elves Way, Columbia, MD 21044.

Feasibility of Introducing Food Crops Better Adapted to Environmental Stress, Volume 1; NSF/RA-780037; NTIS Order No. PB280030/NKS; 113 p.

Feasibility of Introducing Food Crops Better Adapted to Environmental Stress, Individual Crop Reports, Volume 2; NSF/RA-780038; NTIS Order No. PB281369/NKS; 213 p.

The primary objectives of the study are: (1) evaluation of plant species identified and suggested as potential new crops for the U.S.; (2) selection of at least 15 promising species for further testing; (3) evaluation of available information about these species; and (4) formulation of detailed plans for a Phase II study. Suggestions regarding new crops were solicited from more than 100 experts in the U.S. and abroad. Fifty-four crops of interest were selected and detailed information regarding botanical, stress adaptation, agronomic and economic characteristics was collected. This information is presented in tabular form in Volume I. Twenty of the more promising crops were singled out for closer economic and feasibility and impact studies. Most of the industrial crops, possibly three pulses and several grain and speciality crops, show promise in terms of individual producer advantages, marketing and processing benefits, and benefits to the national economy, including judicious usage of land, water, and energy. The feasibility of introducing a new crop depends not only on solutions to technical agronomic and economic problems, but on the availability of a functioning production-marketing-consumption system. Volume 2 presents individual crop reports concerning the 54 selected crops.

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Chemical Threats to Man and the Environment

7. **Approaches for the Acquisition of Mass Spectral Data for Inclusion in the NIH/EPA Mass Spectral Data Base;** AEN7719673; D.P. Martinsen; Fein-Marquart Associates, Inc., 7215 York Road, Baltimore, MD 21212.

Approaches for the Acquisition of Mass Spectral Data for Inclusion in the NIH/EPA/MSDC Mass Spectral Data Base, Final Report; NSF/RA-780242; NTIS Order No. PB285868/NKS; 33 p.

The purpose of this project was to investigate ways in which mass spectral data, particularly that being generated with the support of government funds, could be made available for addition to the NIH/EPA/MSDC Mass Spectral Data Base. Several different approaches were studied: (1) the producers of mass spectral data were contacted directly regarding the submission of their spectra to the data base; (2) the government agencies that sponsor research in which mass spectral data are generated were contacted to see if some policies could be enacted to encourage or require investigators to submit their spectra to the data base; and (3) the scientific journals were examined as a source of mass spectral data to be included in the data base. The findings of these studies indicate that contacting the producers directly is the most fruitful method to acquire spectra. Possible means of locating the producers are discussed. Trying to establish policies governing the reporting of data under government research grants seems an almost impossible task. Obtaining spectra directly from the primary journals is not worthwhile in most cases; however, the journals do seem to be a good source of the identity of the producers of mass spectra.

* * * * *

8. **Development of Antisera to Benzo(a)pyrene and Its Metabolites;** AEN7719689; K. Painter; Western Chemical Research Corporation, 2300 N. Highway 287, Fort Collins, CO 80521.

Development of Antisera to Benzo(a)Pyrene and Its Metabolites, Final Report, Phase I Project; NSF/RA-780468; NTIS Order No. PB293573/NTS; 18 p.

This project performed the necessary synthetic chemistry and immunology to develop antisera to benzo(a)pyrene (BP) and its metabolites. A feasibility study was conducted in the synthesis of BP conjugates for use in immunizing animals to produce antisera against BP and its metabolites. The authors demonstrated the feasibility of BP conjugate preparation by synthesizing seven BP conjugates. Six of the conjugates were characterized and each was injected into three white New Zealand rabbits (18 animals in total), and the animals are currently receiving booster injections. Since only 5mg quantities of the precursors were available, the synthetic route employed involved a reaction of the various hydroxy BP precursors with phosgene to yield chlorocarbonate derivatives, which were then coupled to bovine serum albumin(BSA) by standard methods. The feasibility of preparing BP-BSA conjugates with small amounts of starting materials is demonstrated. Animals were also immunized with these materials, but it is too soon to begin to evaluate the immunological response. It is quite feasible to prepare immunogens of suspected environmental pollutants. The implication is that antisera can be elicited and harvested to be used in the development of more sensitive methods of monitoring chemical threats to the environment.

* * * * *

9. **Mycotoxins as a Potential Human Health Hazard;** AEN7719655; A.C. Ghosh, A.L. Demain, J.M. Townsend, et al.; Sisa, Incorporated, 767 B Concord Avenue, Cambridge, MA 02138.

Mycotoxins as a Potential Human Health Hazard, Final Report; NSF/RA-780052; NTIS Order No. PB286976/NKS; 72 p.

Research is reported in the development of a methodology for the detection and estimation of toxins elaborated by molds frequently encountered as contaminants in soybeans, rice, wheat, chocolate syrup, cheese, flour, and animal feedstock. Thirty-five fermentation experiments using twelve penicillia and thermophilic fungi and five experiments with *P. islandicum Sopp* were carried out. Two potent toxins, cyclochlorotine and simatoxin, were isolated from the crude fermentation products. The detection limit of the thin layer chromatographic technique for the detection of pure cyclochlorotine was found to be approximately 1 part per million. Simatoxin and lumiluteoskyrin, the photoproduct of luteoskyrin, showed considerable mutagenic activity against *Salmonella typhimurium*. The possibility that the carcinogenic activity previously ascribed to luteoskyrin and cyclochlorotine could in fact be due to the presence of lumiluteoskyrin and simatoxin, respectively, as impurities, is noted.

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10. **Reactive Tapes for Automatic Environmental Analyses;** AER7719771; L.D. Nichols; Moleculon Research Corporation, 139 Main Street, Cambridge, MA 02142.

Reactive Tapes for Automatic Environmental Analyses, Personnel Vapor Monitoring Badges for Industrial Workers, Final Report; NSF/RA-780039; NTIS Order No. PB280622/NKS; 29 p.

This project demonstrates that Poroplastic film, and related technology, can combine with colorimetric chemistry to provide prompt visual detection of hazardous vapors at real levels of interest, and that badges based on this technology would be a viable commercial product of major public benefit. Threshold and saturation color levels for phosgene and formaldehyde, two representative toxic vapors, have been examined using reagent-impregnated Poroplastic films. The results prove adequate for both acute, single time exposure limit (STEL) badges and chronic, time weighted average (TWA) badges based on present NIOSH guidelines. Detailed phosgene studies show that shelf life, dose response, specificity, and resistance to desensitization by other vapors are good, and can be improved by appropriate additives and modified solvents. Similar improvement in post-exposure color stability has been demonstrated, and further improvement in this one area is all that is required for a fully satisfactory phosgene product.

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Societal Demand Technology

11. **Control of Fragment Size Distribution and Damage Penetration During Machining of Ceramics;** APR7719818; H.P. Kirchner, R.M. Gruver, D. Richard; Ceramic Finishing Company, State College, PA 16801.

Fragment Formation and Damage Penetration During Machining of Ceramics; NSF/RA-780042; NTIS Order No. PB278709/NKS; 67 p.

Mechanisms of fragment formation and damage penetration during abrasive machining of ceramics are studied. Methodology includes applying the techniques and theory of indentation fracture mechanics to the study of abrasive machining. Specimens of glass and hot pressed silicon nitride were damaged by controlled scratching and single point diamond grinding. Vertical and horizontal forces acting on the material were measured for various diamond shapes, set depths, and wheel speeds. The damage was characterized by optical and scanning electron microscopy. The various types of cracks that were formed were identified and found to be similar to those formed by static contact and particle impact. The vertical forces were correlated with the extent of damage and the results were found to be consistent with those expected based on the theory of indentation fracture mechanics. Initially, the penetration of damage was analyzed in terms of contact loading, and resulted in improved understanding of the effect of diamond shape on the variation of the forces and damage penetration manifested by variations in the dimensionless contact constant X. Next, the results were analyzed in terms of line contact loading, which allowed the results for hot pressed silicon nitride and various diamond shapes to be represented by a single value of X.

* * * * *

12. **Development of Single Ended Photoelectric Hazard Warning;** APR7719478; M. Hercher, K. Dutta; Block Engineering, Inc., 19 Blackstone Street, Cambridge, MA 02139.

Development of a Single-Ended Photosensor, Final Report; NSF/RA-780557; NTIS Order No. PB294099; 66 p.

The project goal was to design, build, and test a single-ended photoelectric sensor which would produce an alarm output in response to the presence of an object within a specified region of space located at some distance from the sensor. Since none of the currently available photosensors achieve the sensitivity potentially attainable with currently available inexpensive LED's (Light Emitting Diodes) and silicon photodiodes, the intent was to develop a photosensor which fully exploits this potential and to then apply this type of photosensor to a number of significant problem areas. To that end, such a photosensor system was developed and a portable and economical aid for the blind was designed. The photosensor system that was built has attained a signal-to-noise of 2 in detecting a matte black surface at a distance of 4 meters. The aid for the blind, which is described in detail, could be carried in one hand and would emit a narrow low power beam of infrared radiation. Any time this beam intercepted an object between approximately 3 and 20 feet away, it would alert the user not only to the presence of the object, but also to its approximate distance. This system is entirely adequate for use as a safety device to prevent manual contact with high-speed motors, saw blades, high voltage terminals, etc. The system could detect a hand at a distance of 1 meter with a S/N of better than 20 and with a response time of 0.02 sec.

* * * * *

13. **Hydraulic Bursting of Concrete and Rock;** APR7719804; W.C. Cooley; Terraspace, Inc., 304 North Stonestreet Avenue, Rockville, MD 20850.

Research on Hydraulic Bursting of Concrete and Rock, Final Report on Phase I; NSF/RA-780058; NTIS Order No. PB283896/NKS; 41 p.

This research demonstrates the feasibility and optimizes the process of hydraulic bursting of concrete and rock. The project has demonstrated a new method for safely and efficiently disintegrating concrete and rock with low noise and low dust, for potential application in demolition or excavation in urban areas where blasting may not be allowed. The method involves drilling holes approximately 1.5 inches (38mm) in diameter to depths of about 6 inches (150mm) into the face, inserting a packer-injector unit and injecting water at pressures of 1000 to 2200 psi (6.9 to 15.2MN/m^2) which causes the brittle material to fail in tension. Splitting of sandstone and Indiana limestone parallel to the drillhole was achieved. It was found that cracks could be initiated transverse to the drillhole and cones of concrete removed by applying a tension force to the packer prior to water injection.

This conical failure mode is also attainable by tension alone on a rock anchor. A design concept for a tension fracture system is presented.

* * * * *

14. **Lowering of Energy Consumption in Plastics Processing;** APR7719512; I. Klein, R. Klein, D.W. Riley; Scientific Process and Research, Inc., 400 Cleveland Avenue, Highland Park, NJ 08904.

Lowering of Energy Consumption in Plastics Processing; NSF/RA-780558; will be available from NTIS.

The research explores the potential of a new plastics processing device, the Recycle Screw, to lower energy consumption and to improve the overall efficiency of the plastics extrusion process. Methodology included a large scale computer-based investigation employing the performing organization's computerized physical model of the plasticating extruder, EXTRUD, and their Data Bank of processing properties of plastics. Almost 1,700 successful simulations were performed using physical properties representing 17 different resin grades covering the most widely used families of polymers. The study extended over five different extruder sizes. Findings show that the innovation under study offers considerably greater benefits than originally expected. In addition to savings in energy consumption of around 75%, or the equivalent of 30 million barrels of oil annually, based upon the expected production levels of the plastics industry by 1985, the new device also shows much more substantial savings through: 1) lower extru-date temperatures of up to 200 degrees F; 2) drastically lower requirements of costly heat stabilizers; 3) lower cooling load and cooling water requirements; 4) lower scrap production by generating higher quality — low temperature extrudate; 5) considerable increases in production rate on existing processing machinery; 6) and through a decrease in capital investments by utilization of smaller cooling lines and associated plant facilities.

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15. **SlideStore: (TM) Large Capacity Information Storage;** APR7719528; E.M. Kaczorowski, D.F. Taylor, L.Y.L. Shen; OMEX, 2323 Owen Street, Santa Clara, CA 95051.

SlideStore Large Capacity Information Storage, Final Report; NSF/RA-780067; NTIS Order No. PB284479/NKS; 71 p.

This study evaluates prospects in areas key to the development of a large capacity optical storage system which records information by forming submicron holes in a thin metal film. A survey of commercially available microscope objectives found that 500 hole fields were an upper limit in performance and could be used with A-O deflected beams for Reading and Writing. A high performance objective lens was designed having a field of 2,000 submicron points. With such a lens, desired data rates could be achieved with mechanical scanners. The output characteristics of several laser diodes were examined. Tests using a micro-cyclindrical lens to confine the highly asymmetric beam revealed extreme sensitivity to lens positioning and modulation caused by feedback of reflected light into the lasing cavity. A Read/Write Subsystem was built to make quantitative measurements of media sensitivity and defect rate. A variety of metal films were tested as recording media. The threshold energy was measured for film thickness, composition, substrate material, and pulse duration to characterize the operating domain for this recording mechanism. Films were produced in which interference enhanced the media sensitivity. Theoretical calculations were made of threshold energy and a bibliography compiled of related publications.

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Improving the Productivity of the Physically Handicapped

16. **Microprocessor — Based Prosthetic Control;** APR7719672; D.E. Gustafson, P.C. Doerschuk; Scientific Systems, Inc., 1640 Massachusetts Avenue, Cambridge, MA 02138.

Microprocessor-Based Prosthetic Control, Phase I, Final Report; NSF/RA-780068; NTIS Order No. PB286652/NKS; 97 p.

The objectives of the present study have been to investigate the feasibility of using advanced signal processing and pattern recognition techniques in a multifunction prosthesis. The specific problem area addressed is industrial productivity, which is presently quite limited for people using prosthetic devices. It is felt that this limitation essentially is due to the problem of fast and accurate detection of the person's intent, since once intent is known power assistance can be given using present state-of-the-art technology in actuators and motors. This study has been limited to a preliminary feasibility analysis of multifunction discrimination using myoelectric signals, a method which has not yet been reduced to practice. Present prostheses require many electrode pairs for multifunction control and thus are subject to limitations and restrictions which appear undesirable. The present approach specifically is designed to ameliorate these difficulties and uses a newly-developed pattern recognition technique which offers great speed and has desirable statistical optimality properties. Results presented are thought to demonstrate concept feasibility.

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17. **Remote Employment of the Physically Handicapped;** DAR7719497; Multisystems, Incorporated Cambridge, MA 02138.

Remote Employment of the Physically Handicapped NSF/RA-780199; NTIS Order No. PB285614/NKS; 110 p.

This report investigates the overall feasibility of employing physically handicapped people in their homes. The concept of home employment of the handicapped is an attempt to solve an often-cited and long-recognized societal problem in significant new ways using telecommunications. The handicapped employee would have a computer terminal at home which would be used to perform work on a computer located at the employer's place of business or elsewhere. Ordinary telephone lines can be used for data telecommunications. Through telecommunications, large numbers of permanently and temporarily disabled people could be employed. Existing computer technology is adequate to support this type of employment and is available at reasonable cost. An analysis of costs and benefits of the technology is given, and problems with remote employment are discussed.

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18. **Visual Feedback Speech Training System for the Deaf;** APR7719883; W.C. Gish; Integrated Sciences Corporation, 1640 Fifth Street, Santa Monica, CA 90401.

Visual Feedback Speech Training for the Deaf, a Feasibility Report; NSF/RA-780043; NTIS Order No. PB281139/NKS; 56 p.

This report proposes a new visual feedback training system for the deaf. This new aid would use a sophisticated multi-step process for the extraction of a meaningful visual representation of speech. The overall approach is shown to be feasible and further research aimed at developing the necessary signal processing algorithms is recommended. The report discusses several visual feedback aids that are representative of past and present devices and shows that their lack of success is primarily a result of inadequate feedback. A definition of adequate feedback and its justification is presented. The feasibility of providing this feedback was investigated and state-of-the-art signal processing techniques for extracting the acoustic features of the high pitched voices of women and children were found to be the primary stumbling block. Very recent research in speech and signal processing which has not yet been applied to the problem of visual feedback aids is the basis for the approach and is discussed in some detail. An extensive bibliography is included.

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Food Substitutes and Composite Materials

19. **Technology Assessment of Advanced Composite Materials;** ERS7719467; R. Kaiser; Argos Associates, Inc., 12 Glengarry, Winchester, MA 01890.

Technology Assessment of Advanced Composite Materials, Phase 1, Final Report; NSF/RA-780053, NTIS Order No. PB283416/NKS; 238 p.

The principal high performance fibers currently used in advanced composites are graphite, aramid, and boron. In the future, these will be supplemented by other high strength fibers such as alumina, silicon carbide, and boron nitride. Organic matrix composites, which are evolutionary products of fiberglass reinforced plastics, predominate the technology. Carbon matrix composites, now mainly used in missile components and aircraft brakes, may find medical use as implantable substitutes for bone structures. Metal matrix composites are currently used in aerospace applications of a developmental nature. With further technical development, metal matrix composites, especially short fiber composites, may be used in specialty applications, particularly in energy conversion systems. The commercialization of advanced composites will result in impacts that will be similar to, and marginal to, those of fiberglass reinforced plastics. High performance fibers will be catalysts for increased consumption of glass fibers in reinforced plastics, but otherwise will not affect other basic materials. Areas of application of advanced composites that could result in significant secondary impacts are automotive equipment, general and commercial aviation, agriculture, and the industrialization of space. Advanced composites can be a major tool for petroleum energy conservation, especially in transportation.

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20. **Technology Assessment of Advanced Composite Materials;** ERS7719647; R. Kaiser; Applied Engineering Resources, Inc., 114 East De La Guerra Street, P.O. Box 345, Santa Barbara, CA 93102.

Technology Assessment of Advanced Composites, Phase 1, Final Report; NSF/PRA-7719647/1; NTIS Order No. PB290325; 155 p.

The primary objective of PhaseOne was to develop the approach and basic data upon which a full technology assessment of advanced composite materials could be built. The emphasis is on future use of composites for purposes other than transportation applications, such as construction and mining equipment and other structural items. However, the approach developed is applicable to the complete range of applications, and related issues. The approach combines two features related to methods and data: 1) taking appropriate portions of methodologies of analagous assessments already performed and adapting them to the advanced composite situation; and 2) performing the necessary analyses and projections starting from the available, extensive, and collected source data. How this will be applied in the case of advanced composites is explained in a step-by-step description of the basic data, relationships, projections, and identification of impacts that will comprise the substantive assessment of Phase Two of this program. At the completion of Phase One it appears that the probable future range and amount of composites application is much more extensive than generally recognized, therefore the potential impacts and issues involved are extensive. In particular, issues of national productivity, safety, and subsidies for product development are raised. It is concluded that the future role of advanced composites in applications of a structural nature warrants full-scale study.

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21. **A Technology Assessment of Vegetable Substitutes for Animal Protein as Human Food;** ERS7719549; H.S. Becker, R. Richmond, E.W. Lusas, et al.; The Futures Group, 124 Hebron Avenue, Glastonbury, CT 06033.

Technology Assessment of Vegetable Substitutes for Animal Protein in Human Food, Volume 1, the Study, NSF/RA-780070; NTIS Order No. PB284681/NKS, 136 p.

Technology Assessment of Vegetable Substitutes for Animal Protein in Human Food, Volume 2, Appendices; NSF/RA-780071; NTIS order No. PB284682/NKS; 72 p.

This report encompasses a detailed technology assessment of vegetable substitutes for animal protein in human food. Vegetable protein is being used in the United States as analogs, ingredients, and extenders of meat and dairy products. Studies have indicated that over the next 10-15 years, emphasis will be placed on using vegetable protein as a meat extender, rather than a direct analog. Several factors are involved in substituting vegetable protein, one of the most important of which is the form the substitution should take. In Volume 1, recommendation is made for a complete technology assessment, which should include all important technological and socioeconomic factors. Volume 2 presents a discussion of metabolism, daily protein requirements and the impact of changes in protein intake. A "mini" technology assessment of the use of vegetable substitutes for animal protein as human food includes: (1) factors important to food-consumption patterns; (2) historic food-consumption patterns; (3) important future sources of vegetable protein, including the influence of technology, legislation, and other factors; (4) potential impact of vegetable substitutes; and (5) potential policy implications.

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Resources, Environment, and Productivity

Resources

22. **Bioconversion of Saline Water;** DAR7719732; Biospherics, Inc., 4928 Wyaconda Road, Rockville, MD 20852.

Bioconversion of Saline Water, Phase I Report; NSF/RA-780066; NTIS Order No. PB283768/NKS; 58 p.

Experiments were conducted on the use of algae for removal of salt from water in an attempt to develop an economically feasible, low energy method for the conversion of saline water. Primary project objectives are: (1) to undertake a literature search; (2) to select and obtain algal cultures; (3) to culture algae in sufficiently large volumes for test purposes; (4) to determine suitable methods for evaluation of media and cellular sodium concentrations; and (5) to test various environmental factors for their effect on algal sodium uptake and excretion. The literature search was completed. stock algal cultures were obtained and grown in relatively large culture volumes. Techniques for monitoring cell sodium levels were evaluated for the most efficient means of removing external sodium and for digestion of the cells prior to sodium analysis. Environmental changes indicated in the literature search and which could be easily manipulated were made in attempts to induce uptake/release of sodium from algal cells. Factors selected for experimental manipulation were: pH, salinity, temperature, light vs. dark conditions, addition and depletion of energy sources, addition of toxic compound, and addition of sewage sludge. No significant uptake or excretion of sodium or chloride was obtained in the algal species studied when the selected environmental manipulations were made, with the exception of a possible uptake of sodium when the algal culture was studied in the presence of activated sewage sludge.

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23. **Enhancement of Animal Protein Production by Novel Genetic Technology;** DAR7719654; Collaborative Research, Inc. 1365 Main Street, Waltham, MA 02154.

Enhancement of Animal Protein Production by Novel Genetic Technology, Phase I Report; NSF/RA-780551; NTIS Order No. PB297629; 57 p.

The project concerns an approach for developing a novel vector for inserting known defined segments of DNA into mammalian cells. The ideas were based on the discovery of a reiterated sequence of 21 nucleotides at both the 3' and 5' ends of Rous Sarcoma Virus (RSV) 355 RNA. The reiterated sequence suggests a mechanism whereby integration can occur into the host cell genome at a presumptive integration site with the same sequence. A model compound is prepared to test the ideas of cell penetration and integration. A heptadecanucleotide and tetradecanucleotide corresponding to parts of the reiterated sequence were synthesized. It was confirmed that the sequences are correct by two dimensional mobility shift analysis. These oligonucleotides have been phosphorylated using polynucleotide kinase and tailed with either poly (dA) or poly (dT) using terminal transferase. Cyclization and ring closure reactions were attempted but a problem of nuclease contamination in the samples of DNA polymerase was encountered. The DNA preparations of tetradecanucleotide and heptadecanucleotide tailed with poly (dA) or poly (dT) and an annealed mixture have been examined using electron microscopy. Cell penetration studies are in progress using these preparations. Outlined is the new approach for preparing the circular, double stranded DNA model compound that hopefully will circumvent the problems encountered.

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24. **Controlled Soil Microbial Detoxification of Herbicide Residues;** ENV7719832; George D. Ward & Associates, Environmental Consulting Engineers, 821 N.W. Flanders, Portland, OR 97209.

Controlled Soil Microbial Detoxification of 2, 4-D Herbicide Manufacturing Residue, Phase 1; NSF/RA-780252; NTIS Order No. PB287408/NKS; 99 p.

This study investigated the feasibility of achieving bacteriological detoxification of herbicide and pesticide manufacturing residues through the action of naturally occurring soil microorganisms under controlled soil conditions. Municipal sewage sludge was used as a nutrient source and stimulant for growth and basic support of the soil microorganisms capable of using herbicide and pesticide residues as a food source for carbon. The basic toxic waste material investigated was Trichlorophenol, distilled from 2, 4-D manufacturing residue (tars). Both aerobic and anaerobic soil test samples were incubated in a greenhouse with loadings of TCP at 100 ppm and 1,000 ppm. Soil samples were taken once a week over a two-month period and then analyzed to determine the rate of TCP degradation. For the conditions examined, it was found that naturally occurring soil microorganisms do have the capability of bacteriological degradation of Trichlorophenol in a microbial process that appears to be potentially continuous as well as safe.

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25. **Immunochemical Assay for Asbestos in the Environment;** AEN7719495; H.R. Lukens; Instrumentation Research Technology Corporation, 7650 Convoy Court, P.O. Box 88817, San Diego, CA 92138.

Immunochemical Assay for Asbestos in the Environment, Phase 1: Production of Antibody Toward Asbestos, Final Report; NSF/RA-780469; NTIS Order No. PB294224; 13 p.

Initial work toward the development of an immunochemical method for the determination of asbestos in environmental samples is described. Such a method will be based on antibodies toward asbestos, and the present work indicates success in the production of such antibodies. The method relies on the affinity of antibody to asbestos for the asbestos in the environmental sample of concern. The results presented indicate that the production of antibody to asbestos has been successfully accomplished and this crucial reagent is now available for tests which will allow the specificity and sensitivity of the technique to be established.

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26. **Methodology for Mitigation of Seismic Hazards in Existing Unreinforced Masonry Buildings;** PFR7719523; S.B. Barnes, A.W. Johnson, C.W. Pinkham; S.B. Barnes & Associates, Los Angeles, CA 90053.

Methodology for Mitigation of Seismic Hazards in Existing Unreinforced Masonry Buildings, Phase 1; NSF/RA-780132; NTIS Order No. PB287478/NKS; 69 p.

Unreinforced masonry buildings are studied in order to determine appropriate methods to deal with hazard mitigation and to study methods of retrofit so that design methods can be established. These design methods are to be devised with consideration of the particular structural conditions of unreinforced masonry construction, their earthquake response, the seismicity of the particular location, and the economics of retrofit. Phase I has studied the state-of-the-art of hazard mitigation and retrofit in order to determine those concerns requiring additional testing and analysis not currently available to complete the design methodology. An outline of the design methodology has been established and each item in the methodology has been discussed in sufficient depth to determine further study items. A set of suggested criteria has been proposed with omission of those items where additional work is required. Finally, a summary of these further study items has been included so that the work to be performed in Phase II can be identified.

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27. **Mitigation of Seismic Hazards in Existing Unreinforced Masonry Wall Buildings: Performance of Undesigned & Modified Elements: Evaluation of Modification Methods;** PFR7719651; Kariotis, Kesler & Allys, 1414 Fair Oaks Avenue, South Pasadena, CA 91030.

Mitigation of Seismic Hazards in Existing Unreinforced Masonry Wall Buildings, Performance of Undesigned and Modified Elements, Evaluation of Modification Methods; NSF/RA-780130; NTIS Order No. PB278927/NKS; 34 p.

This investigation attempts to ascertain if mitigation of seismic hazards posed by existing structures using unreinforced masonry walls can be accomplished by simple methodology. Subtopics of this investigation include performance of the undesigned elements that participate in structural response and evaluation of current modification methods applied to these undesigned elements. Interviews with technical personnel and a survey of existing masonry buildings was made in representative areas of the United States that may be subjected to ground motion varying from moderate to severe. This survey indicates commonality of building construction methods, range of building dimension, and use of masonry materials. Analytical studies of a representative structure with a flexible horizontal diaphragm were made by typical design procedures and simplified mathematical models subjected to various ground motions. The studies indicate that structural response of vertical and horizontal elements can be defined for analysis purposes by simple parameters. Prior and current research into material properties of masonry was reviewed to extract general data applicable to reinforced masonry. It concludes that development of a methodology for mitigation for seismic hazards in unreinforced masonry buildings is feasible.

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28. **A Portable Vibrating Structure for Soils Investigations;** PFR7719653; P. Ibanez; ANCO, Inc., P.O. Box 24313, Los Angeles, CA 90024.

A Portable Vibrating Structure for Soils Investigations; Final report not available at this time. Technical Summary follows:

One of the largest sources of uncertainty in evaluating the seismic response of important structures such as nuclear power plants is the error in soil parameters used in the soil-structure interaction model. No adequate method for high strain in situ measurement of soil properties is currently available. This award is to develop such a method consisting of a portable structure excited by eccentric mass vibrators. The measured response of the structure would be coupled with theoretical models of the soil and a Bayesian parameter identification scheme to back evaluate critical soil parameters. Improved confidence in soil parameters would reduce expensive conservatism in nuclear power plants.

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Environment

29. **A Rational Approach to Damage Mitigation in Existing Structures Exposed to Earthquakes;** AEN7719463; Earthquake Engineering Systems, Inc., 141 Battery Street, Suite 400, San Francisco, CA 94111.

Rational Approach to Damage Mitigation in Existing Structures Exposed to Earthquakes, Phase I Report; NSF/RA-780299; NTIS Order No. PB288365/NKS; 95 p.

This study examined the feasibility of developing a Rational Decision Analysis Methodology to be used by building owners and managers and by the financial and insurance industries in the evaluation of possible modification schemes for [illegible] buildings exposed to a predicted earthquake. Available procedures to determine the expected earthquake hazard at a given site were studied, and a methodology to apply the results of these procedures to the decision-making process is presented. A procedure to calculate the damages to various components of a building due to different levels of ground shaking was developed. To provide flexibility for future development, the indirect damages related to events like fire and substructure failure and their respective probabilities were also included. A computer program, DAMSTAT, was developed to automate the calculation steps for this proposed methodology. A description, listing, and application of this computer program is presented. The usefulness of the methodology greatly depends on the ability to estimate the damages to a building due to a given earthquake intensity. Therefore, a method to generate damage matrices from historical damage data was developed to estimate the expected damage successfully. This method was applied to masonry buildings, and a number of damage statistics curves were generated for four classes of masonry buildings. Results of an extensive literature search, performed to gather information on the performance of the older masonry Type III low-rise building during previous seismic events, are reported.

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30. **Research on the Response of Existing (Masonry Building) Systems to Earthquake Motion;** AEN7719829; S. Adha, R.D. Ewing; Agbabian Associates, El Segundo, CA 90245.

Methodology for Mitigation of Seismic Hazards in Existing Unreinforced Masonry Buildings, Phase I; NSF/RA-780131; NTIS Order No. PB287898/NKS; 93 p.

A multiphased program is initiated to develop a methodology for the mitigation of seismic hazards in existing unreinforced masonry (URM) buildings. The present research, part of Phase 1, identifies trends in the seismic response of the components of URM buildings and determines what studies and testing are necessary to arrive at a methodology that can be used nationwide. The response of plywood, diagonal-sheathed, and straight-sheathed diaphragms, represented by lumped-mass mathematical models was studied. Experimental data on static loading and unloading were used. Both local and distant earthquake ground motions were used as inputs. The results show a strong dependence of the diaphragm response on the long-period content of the input. The response of masonry walls subjected to in-plane earthquake ground motion was also studied. The analytical results show that the model used can reasonably predict the response of the wall as a function of its soil. The report evaluates methods for selecting earthquake ground-motion input at a site in the United States and describes analysis methods that can be used to determine the response of URM buildings to earthquake forces.

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31. **Seismic Hardening of Unreinforced Masonry Walls Through a Surface Treatment;** AEN7719888; J.R. Cagley; Martin & Cagley, Structural Engineers, Willco Buiding, 6000 Executive Boulevard, Rockville, MD 20852.

Seismic Hardening of Unreinforced Masonry Walls Through a Surface Treatment, Phase I; NSF/RA-780129; NTIS Order No. PB278930; 28 p.

The feasibility of developing an economical and simple method of strengthening unreinforced masonry to resist seismic induced forces through the use of a coating is evaluated. Normal reinforcing methods, the capacity of unreinforced masonry in existing buildings, available masonry coatings, and anticipated stress levels of unreinforced masonry are examined. The use of surface bonding cement to accomplish seismic hardening of existing unreinforced masonry walls offers a potential economic solution to a problem that presently has only expensive solutions. This could result in an immediately available means of upgrading thousands of buildings in a short period of time. This solution does not address all problems inherent in the hardening of existing buildings, but offers substantial additional safety for building inhabitants, and protection from falling masonry.

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32. **The Use of Structural Foams to Improve Earthquake Resistance in Buildings;** PFR7721426; B.L. Gabrielsen, R. Lindskog; Scientific Service, Inc., 1536 Maple Street, Redwood City, CA 94063.

Use of Structural Foams to Improve Earthquake Resistance of Buildings; NSF/RA-780344; NTIS Order No. PB287121; 307 p.

The objective of this program was to develop and test the feasibility of using polyurethane foam to increase the shear capacity of timber stud walls, timber joint floors, and ceilings and foundation to floor connections. Specific tasks were to develop foam placement techniques, document increases in strength due to foam, and to determine the feasibility of using these techniques in new construction. Results indicated that substantial increases in shear strength were achieved in walls, floors, and ceiling systems. For example, a typical sheathed roof or floor system by current code would have no seismic shear resistance. It was shown experimentally that a floor system (2 x 8 joist, 1 x 8 sheathing) when foamed developed a 1650 lb/ft composite shear capacity, and the energy absorbed by a foamed panel was approximately 10 times that of an unfoamed panel. Tests of floor-to-foundation connections upgraded by foam also indicate substantial increases. Structural foam was found to be a viable and inexpensive alternative to conventional rehabilitation techniques.

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Productivity

33. **Commercial Waste Food Recycling for Swine Production;** ERS7719811; Oriental Engineering and Supply Company, A Division of Tseng Enterprises, Inc., 670 Newell Road, Palo Alto, CA 94303.

Commercial Waste Food Recycling for Swine Production, Final Report; NSF/RA-780036; NTIS Order No. PB281566/NKS; 122 p.

The feasibility of commercial waste food recycling for swine production is examined. Large amounts of waste material from restaurants and food processing plants, suitable for swine or animal feed, are currently being wasted by their disposal in land-fill operations or are sent to sewage plants causing treatment problems. A system devised for the economical recovery of this potential animal food material could serve to increase the available high protein food supply. Possibly, it could allow the production of high protein food (meat) at lower cost. Since most urban areas of the United States are finding it more and more difficult and expensive to dispose of waste material by land-fill, recycled restaurant and food processing wastes might alleviate the problems of land-fill disposal of urban waste material. This study encourages those now engaged in animal feeding to consider methane generation from animal wastes in order to add to the U.S. energy resources. The text is based on the model of collecting food wastes from San Francisco Chinatown restaurants, food processors, and grocery stores for use in swine feeding at the pig farms in the Bay Area. Special efforts have been made to identify the cultural backgrounds that will make the collection system, food waste composition, and social disciplines that are needed in order to make such a recycling system functional.

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34. **Composite Materials Comprising Reaction-Injection-Molded Combination of Carbon Fibers and Thermosetting Resins;** ERS7719711; F. Hostettler, G.C. McCormick; Plastics Technology Associates, Inc., 503 Adamston Road, P.O. Box 868, Breton Woods, NJ 08723.

Research on Composite Materials Comprising Reaction-Injection-Molded Combinations of Carbon Fibers and Thermosetting Resins; NSF/RA-780508; NTIS Order No. PB278979; 40 p.

This project explores whether or not the reinforcement of polyurethane and polyepoxide resins with carbon or polyaramide fibers (Kevlar) could be accomplished by means of reaction-injection-molding (RIM) technology. This study of the applicability of RIM processing technology for the manufacture of light weight structural fiber-polyurethane or fiber-epoxide components, suitable for use by the automotive industry, has shown that the process will probably attain commercial significance, provided that sufficient further exploratory research be conducted to answer many unresolved problems. The injection of non-filled polyurethane and/or polyepoxy resins into a cavity which contains woven or non-woven carbon or Kevlar fibers is preferable to the use of fiber slurries. Such slurries were shown to exhibit prohibitive viscosity characteristics. The proposed process should be explored from many viewpoints including: (1) exploration of better methods of wetting the surface of carbon and Kevlar fibers for the purpose of using these fibers in RIM polyurethane, polyisocyanurate, and polyepoxy matrixes; (2) explorations of high fiber loadings by means of RIM technology researching the possible methods by which this can be accomplished; (3) exploratory investigation of mold designs suitable for use with reinforced RIM systems; and (4) critical evaluation of delivery systems capable of accomplishing the afore-described tasks, including vacuum mold filling techniques.

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35. **Hydromechanical Sensing of Deep Hole Drilling Deviations;** APR7719526; F.H. Shipman; C.J.H. Brest Van Kempen; TerraTek, Inc., University Research Park, 420 Wakara Way, Salt Lake City, UT 84108.

Feasibility Study of Hydro-Mechanical Borehole Deviation Sensing, Final Report; NSF/RA-780084; NTIS Order No. PB284612/NKS; 43 p.

Presented are the results of a preliminary study and testing of a concept for a borehole deviation sensing system for use in long horizontal drilling applications. Considered were relevant problems, applications, and techniques currently encountered in the drilling industry, with emphasis placed on long-hole horizontal drilling. The concept of hydro-mechanical deviation sensing using drilling fluid is described and developed in detail. A design of a working model with which to ascertain a measurement of the important parameter of borehole straightness sensitivity is examined. Some of the more important uses of drilling small non-vertical holes in the earth are found in minerals exploration, mining applications, tunneling surveys, utilities emplacement, and safety. The greatest application in the near future is in providing channels for drainage, primarily methane, in coal mines. The approach presented detects, at a very high level of sensitivity, an incipient tendency of the drilled hole to deviate from a straight line. Preliminary test results using a model of the sensor indicate its straightness measurement sensitivity to be .003 in/ft of penetration.

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36. **Improved Methods for the Rapid Detection of Microbial Contaminants;** 7719701; R. Wang; International Diagnostic Technology, Santa Clara, CA.

Improved Methods for the Rapid Detection of Microbial Contaminants, Final Report; NSF/RA-780509; NTIS Order No. PB296221; 25 p.

The IDT FIAX system has been demonstrated to be useful in the detection of various serum constituents by employing a solid-phase immunofluorescence technique. An attempt was made to extend the use of this system to the detection of microbial contaminants, such as bacteria themselves or toxins produced by microorganisms. Escherichia coli was used as a model for demonstrating the feasibility of using the system for detection of microbes. Initial results indicate that the detection of microorganisms by the solid-phase immunofluorescence method is quite feasible with further development. Study has shown that by inhibiting specific fluorescent antibody with bacteria in a sample, less fluorescence is measured with the immobilized bacteria on the assay dipstick. That is, the amount of measurable fluorescence in the assay is inversely proportional to the amount of bacteria in the sample. Direct studies were not conducted on the applicability of the method to the detection of toxins, since it has been previously demonstrated that large biomolecules (serum proteins) and small biomolecules (thyroxine, gentamicin) can be quantitated using the FIAX system.

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37. **In-Vitro Detection of Allergy Using Human Head Hair;** APR7719721; J. Caravaca-Trujillo, C.B. Williams; IRT Corporation, 7650 Convoy Court, San Diego, CA 92138.

In Vitro Detection of Allergy Using Human Head Hair, Phase 1, Extraction of Immunoglobulin E from Hair and Development of an Immunofluorescence Test for Allergy Detection, Final Report; NSF/RA-780235; NTIS Order No. PB285649/NKS; 43 p.

This report deals with research to develop simple, accurate, reproducible, and commercially viable routine clinical laboratory methods for the assay of immunoglobulin (IgE) and IgE antibodies using human head hair. An immunofluorescence technique (IFT) is potentially a diagnostic procedure that could greatly reduce the cost, risk, and inconvenience of allergy testing, thereby making such testing much more broadly applicable and available. Research/analysis objectives and accomplishments, including preparation and characterization of fluorescein conjugates of Bermuda grass and western ragweed, and immunofluorescence test (IFT) on hair for IgE antibodies and allergy detection, are discussed. The report also examines the specificity and reproducibility of IFT as well as the extraction of IgE from human head hair. Conclusions and plans for the utilization of results are given.

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38. **Mass Spectrometry Photoplate for Environmental Trace Analysis Research, Final Report;** 7719728; J.I. Masters; Ionomet Company, Box 56, Waban, MA 02168.

Urgently Needed Mass Spectrometer Photoplate for Environmental Trace Analysis Research, Final Report; NSF/RA-780507; NTIS Order No. PB295072; 36 p.

The feasibility of research leading to a vapor-deposited surface suitable for recording 10-20 kv spark-source mass spectra was examined. Specifications comparing commercial mass-spectrometer photoplates and the performing organizations state-of-the-art gel-free plates show the latter deficient in two important categories, but otherwise superior. These categories are the focus of the research program: sensitivity to 20 kv ions in the 0-300 atomic weight range must be increased 3-10 fold; simultaneously, the latitude of response to ion exposure must be increased one decade to facilitate quantification of mass data, i.e., in photographic terms, lower contrast or reduce the slope of the density vs. log (exposure) curve approximately two-fold. The work involved vacuum technology and photographic chemistry. Vacuum deposited research samples were tested using optical techniques. Final testing was performed at appropriate mass-spectrometer facilities. Research approaches for achievement of primary objectives include: moisturization; gold sensitization; developer optimization; surface etching; vapor deposition of a gel-free overcoating on an inexpensive emulsion plate; substrate heating during vacuum deposition; parameter adjustment with attention to stoichiometry; and pH and pAg adjustment. Moisturization produces significant short term sensitivity and latitude increase. Gold sensitization produces an as yet variable 2-3 fold sensitivity increase.

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39. **Micro-Isotope Tool Wear Detection;** DAR7719517; Amtech Incorporated, 141 California Street, Newton, MA 02158.

Micro-Isotope Tool Wear Detector, Phase I, Final Report; NSF/RA-780124; NTIS Order No. PB284699; 86 p.

The feasibility of the Micro-Isotope Tool Wear Detection System was evaluated as an industrial tool wear monitor, particularly for use with automated machining systems. A field evaluation test was conducted at the General Electric, Small Aircraft Engine Operation in Lynn, Massachusetts on tungsten carbide milling cutters used on computer-controlled turbomachinery milling operations. The first round of testing was not conclusive due to insufficient isotope implant integrity; however, this is not a problem since improved implants were subsequently made and demonstrated successfully on two different machines in a laboratory environment. An attractive design concept was developed for a universal implant fixture that should allow tools to be implanted with micro-isotope particles in an industrial environment by typical tool sharpening personnel producing accurate results at moderate cost. Thus, it seems that this part of the system can be adapted to the industrial environment. Investigations into possible barriers to implementation due to the use of radioactive material revealed that potential users would need an exemption from Nuclear Regulatory Commission user licensing requirements. The application for an exempt status must be pursued and resolved before this potential barrier can be assessed adequately.

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40. **Research on a Low Drag Trawl Board;** APR7719702; C.A. Goudey, Sea Otter Trawl Gear, 50 Mystic Street, Cambridge, MA 02129.

Experimental Hydrodynamic Study of Innovative Trawl Board Designs, Report on Phase 1, Research on a Low Drag Trawl Board; NSF/RA-780040; NTIS Order No. PB278919/NKS; 86 p.

This study addresses the poor hydrodynamic qualities of the trawl boards commonly used by United States fisherman — a major source of trawl system inefficiency. A family of trawl board configurations was developed consisting of 24 different models. All designs were low aspect ratio, untapered, asymmetric foils made up of flat or constant radius surfaces. Variations of sectional shape, aspect ratio, planform and slot location were studied. Water tunnel tests were conducted at Reynolds Numbers of 1×10^6 with the model in contact with a splitter plate to simulate the hydrodynamic effect of trawl board contact with the seabed. Implications beyond the configurations tested were made and a rough analysis of the economic effect of trawl board efficiency is presented. All models tested were found superior hydrodynamically to the board presently used. Reduced drag coefficients and the smaller size would provide as much as a 66% decrease in board resistance. The adoption of such a low drag trawl board would have a significant effect on the economics and productivity of trawling. Fuel savings of up to 20% or increases in catch size of 34% seem feasible.

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41. **Research on the Simplification of Methods for Measuring Fracture Toughness;** APR7719461; L.M. Barker; TerraTek, Inc., University Research Park, 420 Wakara Way, Salt Lake City, UT 84108.

Research on the Simplification of Methods for Measuring Fracture Toughness, Phase 1, Final Report; NSF/RA-780083; NTIS Order No. PB284113/NKS; 24 p.

This report examines new approaches to measuring the material property known as fracture toughness, with the aim of making fracture toughness measurements less expensive and exotic, and more economical and commonplace. A research program, initiated to simplify the methods of measuring fracture toughness in both brittle and ductile materials, is being directed toward the short rod method, which is simpler, yet more versatile, less costly, and at least as accurate as previous methods. An experimental compliance calibration of the short rod specimen configuration was performed, and an alternate specimen configuration was tested. Some experiments were performed in support of a new elastic-plastic theory which promises to drastically reduce the size and cost of most fracture toughness specimens. Research has demonstrated the feasibility of making valid fracture toughness measurements using greatly simplified procedures and much smaller, less costly specimens than are currently used.

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42. **Resource Allocation System for Construction Industry Managers;** APR7719782; J.C. Kellogg, C.V. Carlson, G.H. Beisman, et al., Kellogg Corporation, 5601 S. Broadway, Suite 400, Littleton, CO 80121.

Resource Allocation System for Construction Industry Managers, Final Report; NSF/RA-780060; NTIS Order No. PB297902; 154 p.

Described is the development of ProMed, a series of data and computer packages that describe the construction industry and develop information that will assist construction managers in the decision making process. A demonstration model was developed to determine the potential value, to the construction manager, of directly related usable planning data. A key element of the research was to examine the feasibility of making the ProMed system available to non-computer oriented personnel. The study area selected for analysis was the small housing contractor, building 10 to 100 units per year, within the Colorado region. A linear programming analog entitled "The Three Pigs Construction Company" was developed to illustrate the profit function of two particular types of housing construction. Management science, inventory theory, shortage costs, and generalized transportation problems were also reviewed. The study concluded with the development of a specific network diagram relating to the construction of a typical ten unit housing project and utilization of this data by management science methods.

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